

***California Energy Commission  
2005 Energy Report Committee  
First Workshop on the Water-  
Energy Relationship Whitepaper***

**January 14, 2005**



# Background

- Energy and Water Use are Highly Interrelated
- Energy Commission Identified Need to Study Energy Demand Trends in Water Sector
- Department of Water Resources Identified Need to Study Water Demand in Energy Sector in Water Plan Process
- Agencies Decide to Jointly Conduct Study
  - Ensure consistent assumptions
  - Prevent duplication of effort



# Study Purpose

For the Energy Commission Portion:

- To Accurately Assess Energy Demand in Water Sector
- To Explore Potential to Reduce On-Peak and Total Electric Demand through Water System Conservation, Efficiency and Electric Generation
- To Develop Tools and Programs for Planners, Water Agencies and Companies to Address Energy Needs of New and Existing Systems



# Study Scope

- WER Whitepaper will be Informational in Nature: Informing Decision Makers and General Public of Critical Issues in the Relationship of Water and Energy
- Explore Present Use and Trends in Energy Use of All Portions of the Water Cycle
- Planning Tools and Programs Likely to be Separate Product Developed Jointly by Both Agencies

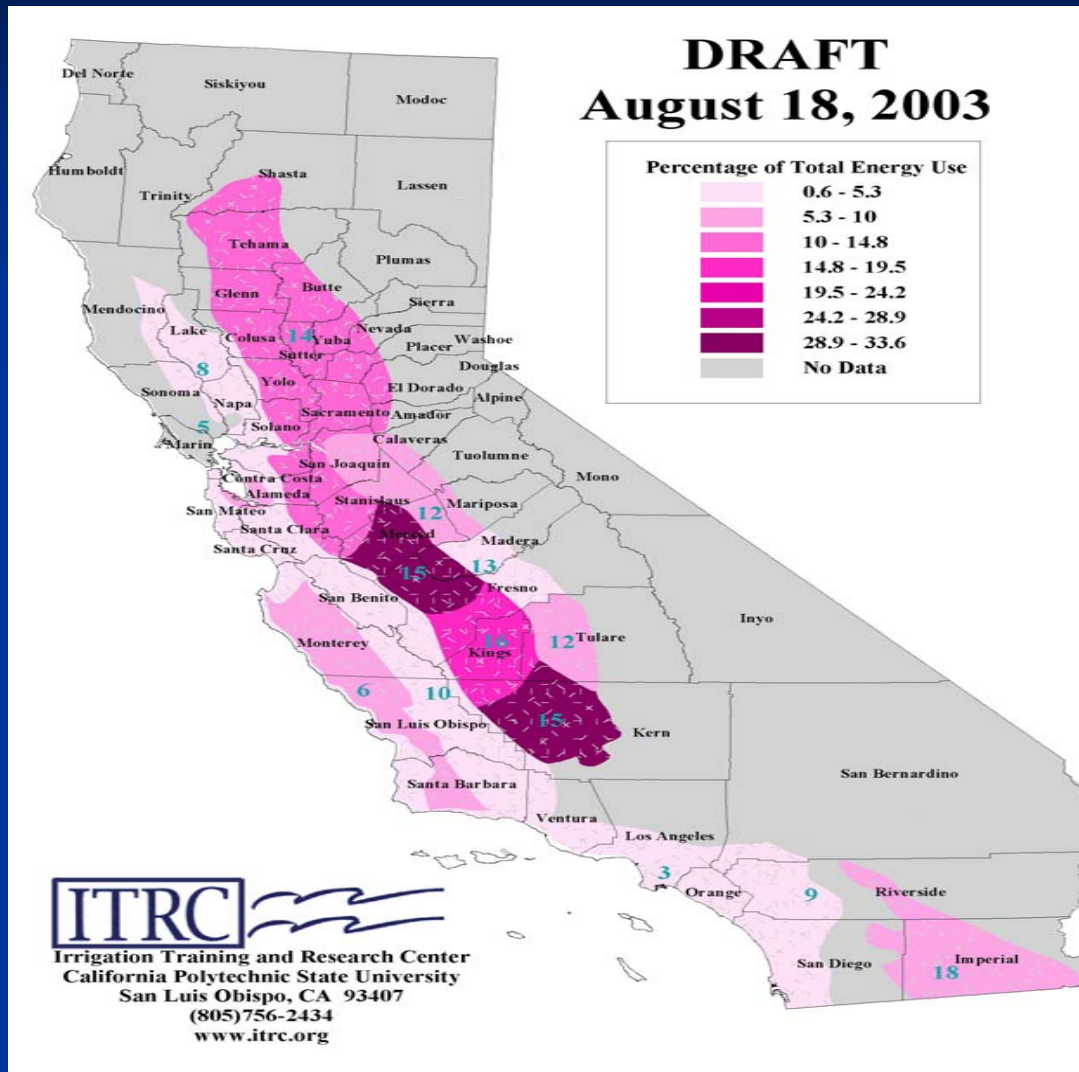


# Present Demand in Water Sector?

- Water Supply 11,953 GWh
  - Includes all pumping for conveyance and distribution
- Treatment 1,388 GWh
  - Includes treatment to potable standards, sewage and wastewater treatment, and disposal
- End-Use 12,482 GWh



# Irrigation and Electricity Use



Total  
Energy  
Demand =  
2,269 GWh



# Trends in Water Sector Energy Use

- Continuing Growth Places Pressure to Find New Supplies for Urban Use
- Changes in Water Market Likely to Change Transfer/Conveyance Patterns
- Clean Water Act Rules (Section 316 A&B, et al.) Affecting Intake Structure Requirements
- Increased Treatment Requirements for Contaminants
- Desalination Plant Proposals
- Increase in Recycled Water Capacity





# Affects of Climate Change

- Energy Commission and DWR Coordinating on Study of Climate Change Effects for IEPR and Water Plan; PIER Conducting Separate Study
- Warming Could Mean More Rain, but Less Snow
- Are We Entering 500-Year Drought?
- Drought Likely to Dramatically Increase Groundwater Pumping and Desalination





# Desalination Technology

## ■ Two Major Types:

### ■ Thermal

- Multistage Flash (MSF)
- Vapor Compression (VC)
- Multi-Effect Distillation (MED)

### ■ Membrane

- Reverse Osmosis (RO)
- Electro-Dialysis (ED)

## ■ Feed Water Sources:

- Agricultural Runoff, Brackish Water, Recycled Water, Wastewater, Seawater, Surface water



# Desalination Technologies

- About 90% of Existing Desalination Plants Use Multistage Flash or Reverse Osmosis
- 8.4 Billion Gallons Produced at 13,600 Plants Worldwide in 2002; 16% in US
- Energy Demand for MSF is Higher than RO
- Cost of Seawater Desalination is Three to Five Times that of Brine Water Desalination
- But Costs are Declining



# Energy Consumption in Desalination

Function of:      Plant Capacity  
                         Feed Water Quality  
                         Pretreatment  
                         Process/Technology

MWD Orange County	5,500 kWh / AF
Carlsbad	5,400 kWh / AF
Tampa Bay	3,567 kWh / AF
Ashkelon (Israel)	4,920 kWh / AF
St. Michael BWRO (Barbados)	1,230 kWh / AF
Chino Basin	1,700 kWh / AF
Desalting Bay Area Sites (Proposed)	
Mirant Pittsburgh	2,500 kWh / AF
Near Bay Bridge	6,333 kWh / AF
Oceanside	7,333 kWh / AF



# Water Sector Energy Use

For West Basin MWD (kWh/AF)

- Imported Water

SWP	3,044
-----	-------

Colorado River	2,044
----------------	-------

- Groundwater

Replenished with Recycled Water	500
---------------------------------	-----

Replenished with SWP Water	3,500
----------------------------	-------

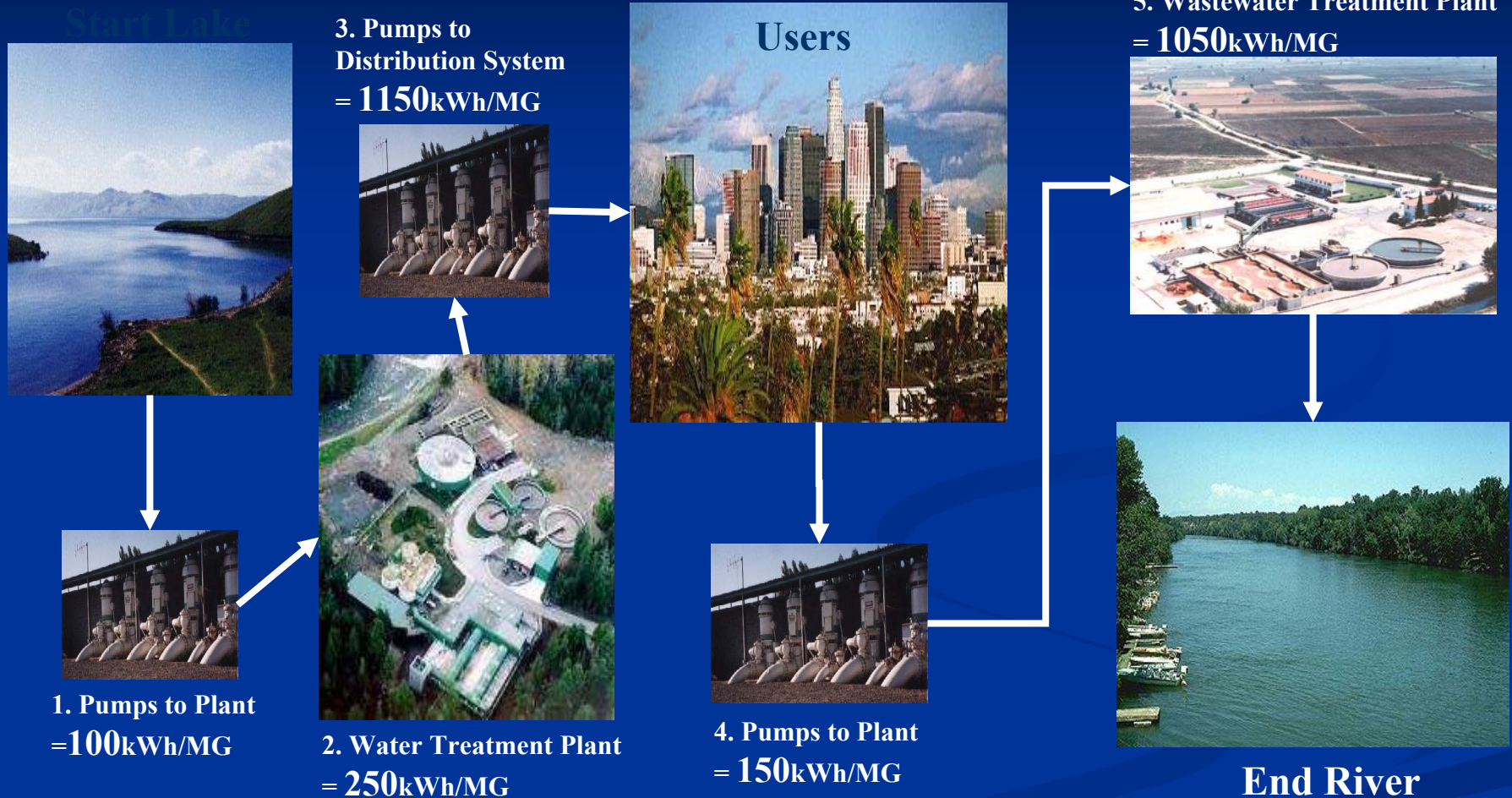
Replenished with CR Water	2,500
---------------------------	-------

Recycled Water	490 – 1,280
----------------	-------------

SW Desalination (estimated)	4,425
-----------------------------	-------



# Typical Energy Use In Water & Wastewater Treatment

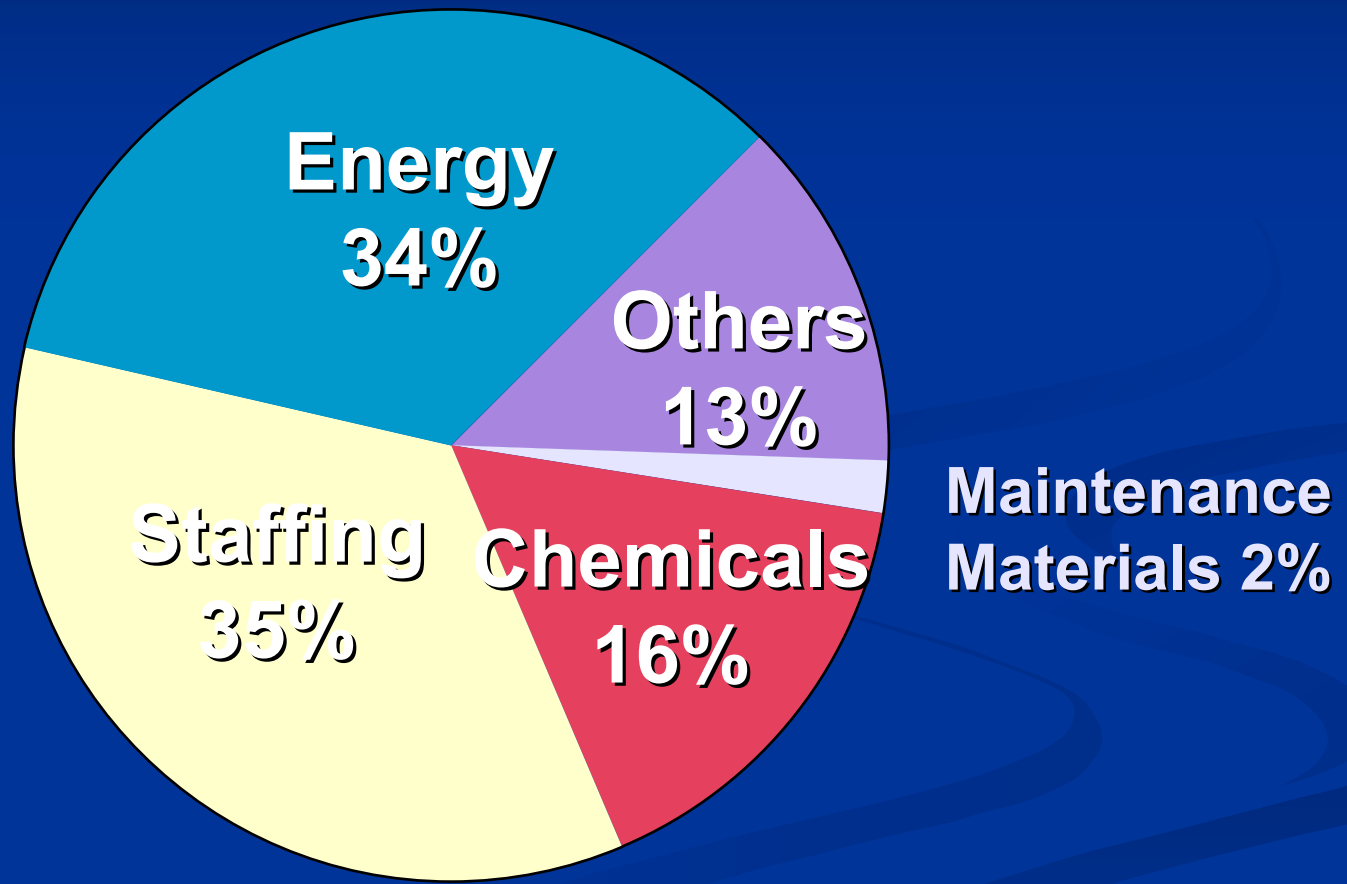


	Step 1	Step 2	Step 3	Step 4	Step 5
Accumulating Total	100kWh/MG	350kWh/MG	1500kWh/MG	1650kWh/MG	2700kWh/MG

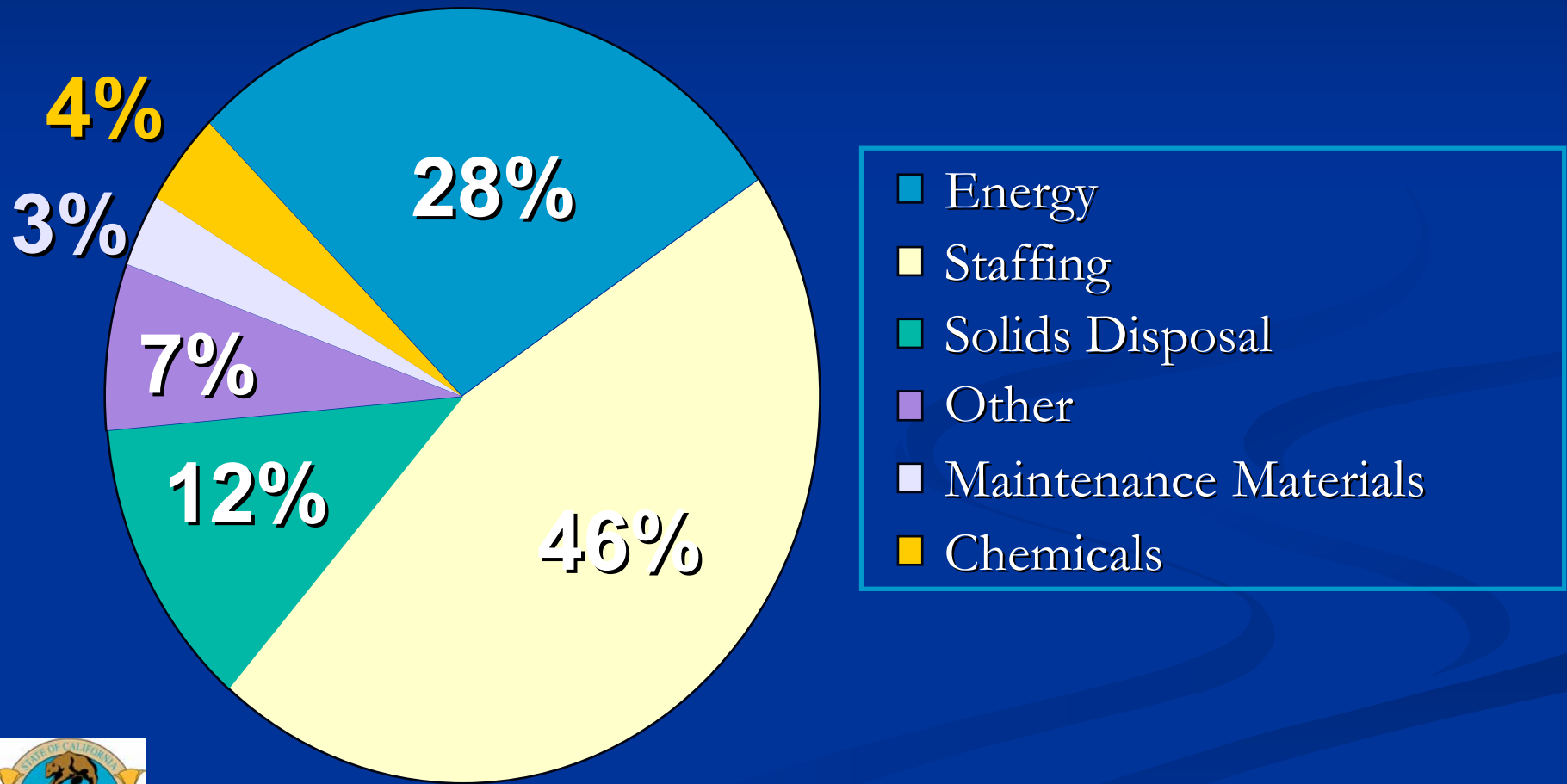




# At Water Facilities, Energy Can Range From 30-50 Percent of Total Operating Costs



# At Wastewater Facilities, Energy Can Be 25-40 Percent of Total Operating Costs





# Future Water Sector Energy Use

- Future → More Water → More Energy

Growing Population

Scarcity of Water Resources

Emerging Contaminants:

Hormones, MTBE, Pharmaceuticals, Diethyltoluamide  
(Bug Repellent), Pesticides etc.

Stringent Water Quality Requirements

Environmental Concerns



# Potential Solutions to Potential Shortage

- Water Conservation
  - Careful Planning Required, as Some Water Conservation Programs Increase Energy Use
- Water System Peak Load Reduction
- Market Transactions to Reduce Long-Distance Pumping (Exchanges, etc.)
- Water System Generation



# Water System Generation

- Micro hydro generation
  - Installed wherever pressure is relieved or energy is dissipated
- In-Stream hydro generation
  - Use of paddle-wheel type turbines
  - Pumped-storage in canals and reservoirs
- Transmission System Limitations
  - Generation potential often far from load
  - Water Agency may have to sell rather than use power
    - Limited transmission capacity to wheel power
    - Few purchasers willing to sign contracts



# Water Demand in Energy Sector

- Refinery/Enhanced Oil Recovery
- Thermal Power Plants
  - Present plants use surface water (seawater and fresh), groundwater and recycled water
- Distributed Generation?
- Renewables?



# PIER Aquatic Resources Projects



Program Objective: Evaluate water conserving power plant cooling technology and alternative sources of cooling water.

- Projects have included: evaluation of dry cooling costs, use of degraded water for cooling, spray enhancement of air cooled condensers, trihalomethane formation in cooling towers and others.
- A conference on alternative cooling research is scheduled for June 1<sup>st</sup> and 2<sup>nd</sup> this year in Sacramento.



# Energy Commission Resources

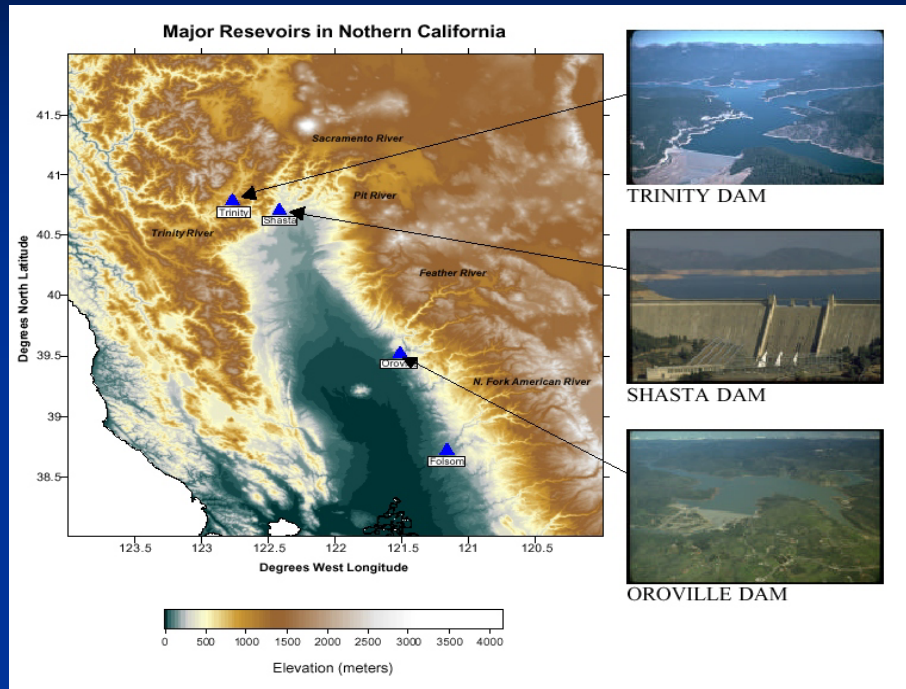
## ■ PIER

- Industrial/Agricultural/Water End-Use Energy Efficiency
  - RD&D focus on improving energy efficiency of processing water for urban, industrial and agricultural consumption
  - Technology transfer to potential end users.
- Global Climate Change
  - Goal to improving data and methodologies for identifying and evaluating possible mitigation and adaptation strategies. Strong emphasis on water resources impacts.
  - Projects include improved statewide modeling of the long-term performance and management of California's water system.





# PIER Aquatic Resources Projects



Program addresses critical need to improve runoff forecasting and balancing between competing water demands

Projects include demonstration of improved runoff and decision making at four Northern California reservoirs, and seasonal forecasting for Pacific Northwest and California hydropower generation.





# Past Studies

CEC - PIER/IAW Desalination Activities

CA Desalination Task Force (AB 2717)

CEC - MWD / DRIP

USBR Roadmap

CEC - MWD / SDCWA NF/RO Desalination

Knowledge Base

CM Working Group

CEC - AWWARF ZLD & Volume Minimization for  
Inland Desalination (AwwaRF RFP 3010)

CEC - USBR Salton Sea Desalination Using  
Geothermal Heat

CEC - West Basin / ERI -- Energy Efficient SW  
Desalination Demonstration

CEC - DWR - USBR Collaboration on Cost  
Effective, Energy Efficient Desalination



# Final PIER Reports on Water

Use of Degraded Water Sources as Cooling Water in Power Plants - Consultant Report Publication #: 500-03-110  
Prepared By: EPRI

Water and Wastewater Technology Demonstration Projects Publication #: 600-00-010  
Prepared By: Edison Technology Solutions

The Formation and Fate of Trihalomethanes in Power Plant Cooling Water Systems - Consultant Report Publication #: 500-04-35  
Prepared By: EPRI

Spray Cooling Enhancement of Air-Cooled Condensers - Consultant Report Publication #: 500-03-109 Prepared By: EPRI

Comparison of Alternate Cooling Technologies for California Power Plants: Economic, Environmental and Other Tradeoffs  
Publication #: 500-02-079F Prepared By: EPRI

Emerging Environmental Technologies Publication #: 500-03-068C Prepared By: EPRI

Climate Change and California Water Resources: A Survey and Summary of the Literature Publication #: 500-04-073

Global Climate Change and California: Potential Implications for Ecosystems, Health, and the Economy Publication #: 500-03-058CF Prepared By: EPRI

From Climate Change Spaghetti to Climate Change Distribution - Consultant Discussion Paper Publication #: 500-04-028 Prepared By: U.S. Geological Survey, Scripps Institution of Oceanography

Input Needs for Downscaling of Climate Data - Consultant Discussion Paper Publication #: 500-04-027 Prepared By: Tom M. L. Wigley

# Contacts

## ■ Questions? Need More Information??

Matt Trask, WER Study Project Manager

916-654-4067      [mtrask@energy.state.ca.us](mailto:mtrask@energy.state.ca.us)

Shahid Chaudhry, Desalination Information

916-654-4858      [schaudhr@energy.state.ca.us](mailto:schaudhr@energy.state.ca.us)

Gary Klein, Water/Energy End-Use Information

916-653-8555      [gklein@energy.state.ca.us](mailto:gklein@energy.state.ca.us)

Joe O'Hagan, Public Interest Energy Research Information

916-653-1651      [johagan@energy.state.ca.us](mailto:johagan@energy.state.ca.us)

